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## Organic farming patterns analysis based on clustering methods

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### Abstract

The purpose of the present paper is to identify viable solutions for organising organic producers groups and supply chains at county level. With this purpose in mind, our research aim was to evaluate which is the best networking solution for 40 organic farmers in Calarasi County. This statistical approach was based on multidimensional scaling and hierarchical clustering methods that permitted us to identify three possible clusters in which to group the organic producers. The evaluation results of the agricultural patterns of each cluster demonstrated that only one cluster is viable for establishing a producers' group. The main characteristics of this cluster are: farmers are in a proximity range of maximum 40 km; at least 75% of farmers have similar farming system types; over 65% of farmers own big farms; the best place for a joint pooling, storing or selling point is the cluster centre (Calarasi). In this way, we consider that a statistical viable solution for clustering and the promotion of networking between farms with similar agricultural patterns can contribute to the creation and establishment of cost-effective supply chains and strong producers' groups.

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### 1. Introduction

The new Common Agricultural Policy supports until 2020 the establishment of producers' groups capable to develop viable supply chains. This type of cooperation can organize the local markets and increase the farms' competitiveness. Integrating organic agriculture in the supply chain is a great challenge for our country due to low productions and higher costs.

For Romania, the topic is more important if we take in consideration that the organic crops (especially cereals) are in great demand on external markets (Popescu and Pop, 2013) and that the establishment of organic markets can

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increase consumption by over 50% (Moise, 2014). In these circumstances, the main objectives for the Romanian organic agriculture are to increase the cultivated surfaces and to promote land consolidation in the sector because the majority of organic farms are under 5 ha (Nelson, 2002) and also to organize the local markets.

But how do we organize these markets, especially when in the sector we notice a high degree of spatial variation which affects land use patterns (Verburg et al, 2003) What is the best way to use the present patterns of land use so we can find solutions to organize the producers? The spatial distribution of land use, farms, industry etc. has answered these questions in the past decades. These studies proved that the location, transport costs and market locations are very important for farmers' incentives and land rents (Alonso, 1964) (Nelson, 2002).

In many of these studies, empirical methods are frequently used to 'find evidence for the proximate causes of land use change and its location' (Turner et al, 1990). The empirical approaches explain the spatial patterns of land use in a theoretical framework or by correlate the land use patterns and the spatial patterns of land use (Chomitz and Gray, 1996).

## 2. Materials and methods

The main purpose of our research was to identify the best way to form organic producers' clusters in Călărași County. The methodology we used has a step by step approach:

- **Step 1** - we identified the organic vegetal producers in the research area and the localities where they are situated;
- **Step 2** – we mapped the research area through statistical methods and identified the optimum number of clusters (Popa and Dona, 2012). For mapping purposes, we used the administrative units and we created a data matrix based on road distances from each locality centre. To analyse this data we apply the following SPSS methods: ASCAL – to visualise the clusters through multidimensional scaling (MDS); Hierarchical Cluster Method (HCM) to establish the proper number of clusters based on the proximity between localities (Centroid Linkage option);
- **Step 3** – for each cluster we identified the centre (the locality that has a better spread and can become trading point for the producers' groups) based on Inverse Distance Weighted and Average Distance Weighted (Scholl and Brenner, 2011);
- **Step 4** – we determined the main characteristics of each cluster regarding the farm sizes and agricultural profiles

## 3. Results and discussions

Călărași County is situated in the south of Romania and contains 53 rural localities. Here, over 400 thousand hectares are cultivated annually and, due to the CAP support, in the last years organic fields have reached almost 1.8% of this area.

In 2013, according to the Department for Agriculture of Călărași County, the organic cultivated area was 6916.6 ha, from which 78.3% certified areas and 21.7% under conversion. From an administrative point of view, only farms in 21 localities maintain this type of agriculture (Belciugatele, Borcea, Călărași, Chirnogi, Cuza Vodă, Dor Mărunt, Dragalina, Dragoș Vodă, Frumușani, Fundulea, Ileana, Lehliu, Lupșanu, Mănăstirea, Oltenița, Roseti, Soldanu, Ștefan cel Mare, Ștefan Vodă, Vâlcelele, Valea Argovei, Vlad Țepeș).

### 3.1. The main characteristics of database

The database comprises the information from 40 farms of different sizes and farming systems. These farms are located in the localities mentioned above and the data were collected for the year 2013. We ranked them by taking into consideration the following criteria: physical size (farm type), farming system (farming type) and certified area share.

'Farm Type' criteria:

- 50% - big farms;
- 12.5% - commercial farms;
- 17.5% - semi-subsistence farms;
- 20% - subsistence farms (Table 1).

Table 1. Farm type distribution

Type		Ha	Number	%
Big farms	BD	Over 50	20	50.0
Commercial farms	CD	20-50	5	12.5
Semi-subsistence farms	SSD	5-20	7	17.5
Subsistence farms	SD	Under 5	8	20.0

Source: Own calculation

‘Farming system’ criteria (over 50%):

- 37.5% - *cereal*, oilseed and protein;
- 12.5% - commercial farms; 15% - forage crops;
- 10% - horticulture (especially vegetables);
- 25% - industrial crops (peas, linseed etc.);
- 5% - orchards (especially apples);
- 2.5% - wine; 5% - mixed crops (Table 2).

Table 2. Farm systems distribution

	Number	%
Specialist COP	15	37.5
Specialist forage crops	6	15
Specialist horticulture	4	10
Specialist Industrial crops	10	25
Specialist orchards - fruits	2	5
Specialist wine	1	2.5
Mixed crops	2	5

Source: Own calculation

‘Certified area’ criteria:

- 35% - only under conversion;
- 45% - between 90-100%;
- 7.5% - between 80-90%;
- 2.5% - between 70-80%;
- 5% - between 50-60%;
- 2.5% - between 40-50% (Table 3).

Table 3. Certified area distribution

	Number	%
40-50%	1	2.5
50-60%	2	5
70-80%	1	2.5
80-90%	3	7.5
90-100%	18	45
Only under conversion	14	35

Source: Own calculation

### 3.2. Clustering formation

The Hierarchical cluster analysis permitted us to group localities with organic agriculture in clusters, the variable computed being the distances between these localities. We chose road distances and not geographical data because our purpose is to identify clusters based on the possible distribution channels.

The clustering solutions offered by the multidimensional scaling are presented in the following figure (Figure 1):

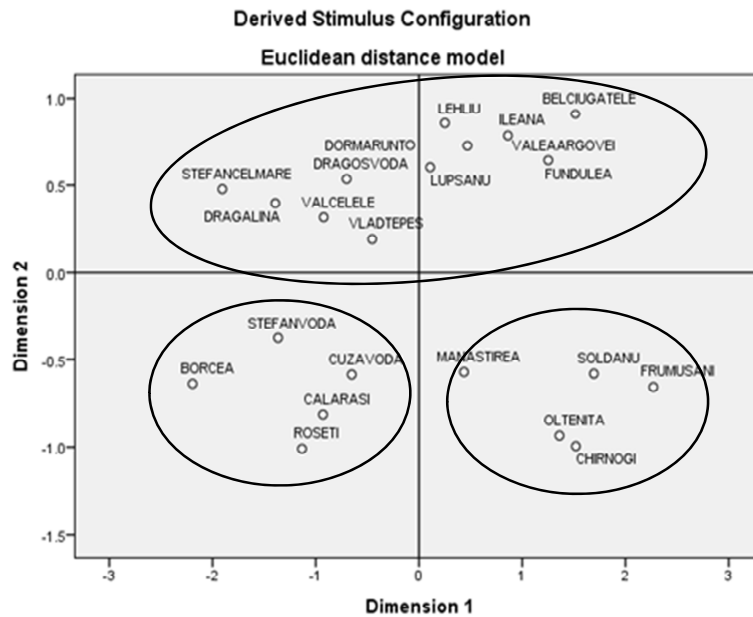


Fig. 1. Optimal two-dimensional configuration computed ALSICAL

The optimal two-dimensional configuration revealed us the possibility to group the localities in three clusters. Starting from these results, we performed a hierarchical cluster analysis (HCM) selecting the same distances matrix, a Squared Euclidean distance method, the Centroid linkage method for clustering and the solution of three clusters. Based on the optimal distances we obtained the following distribution inside those three clusters (Table 4):

Table 4. Cluster membership – Hierarchical cluster analysis

Case	3 Clusters
BELCIUGATELE	1
BORCEA	2
CALARASI	2
CHIRNOGI	3
CUZA VODA	2
DOR MARUNT	1
DRAGALINA	2
DRAGOS VODA	2
FRUMUSANI	3
FUNDULEA	1
ILEANA	1
LEHLIU	1
MANASTIREA	1
OLTENITA	3
ROSETI	2
SOLDANU	3
STEFAN CEL MARE	2
STEFAN VODA	2
VALCELELE	2
VALEA ARGOVEI	1
VLAD TEPES	2

Source: Own calculation.

The dendrogram representing the results shows a viable clustering formation: Cluster 1 – 8 localities; Cluster 2 – 10 localities; Cluster 3 – four localities (Figure 2). But are these clusters optimum for in establishing supply chains?

To find an answer to this question, we first created the distance matrices between the localities of each cluster and assumed that the members of the producer groups have to be less than 50 km from each other.

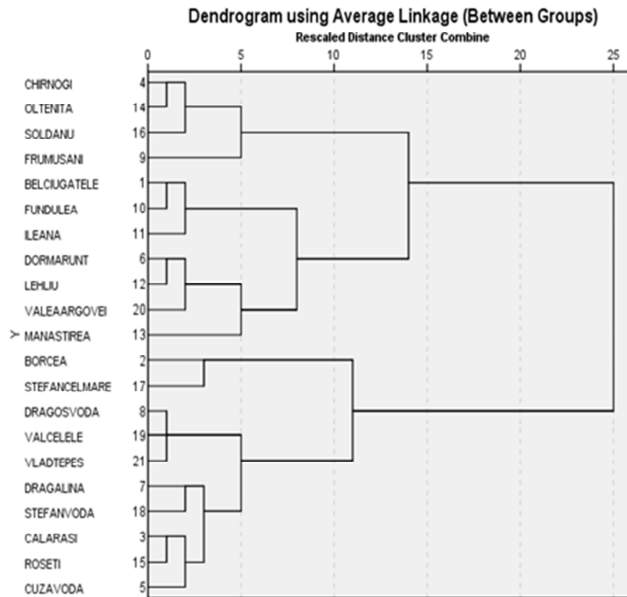


Fig. 2. ALSCAL Dendrogram - Hierarchical cluster analysis

By calculating Inverse Distance Weighted and Average Distance Weighted (Table 5) we verified this hypothesis and also established the centre of each cluster, respectively the locality that has statistically optimum distribution and can become a pooling, storage or selling point (the lowest transport costs).

Table 5. Inverted distances weighted and the weighted average distances

Cluster	Locality	Inverse Distance Weighted	Average Distance Weighted
1	LEHLIU	0.054	18.7
	DOR MARUNT	0.048	20.9
	LUPSANU	0.045	22.2
	ILEANA	0.044	22.6
	FUNDULEA	0.043	23.2
	VALEA ARGOVEI	0.041	24.1
	BELCIUGATELE	0.037	27.3
	MANASTIREA	0.027	37.5
2	CALARASI	0.047	21.5
	VALCELELE	0.045	22.1
	CUZA VODA	0.045	22.2
	DRAGOS VODA	0.043	23.0
	DRAGALINA	0.039	25.6
	VLAD TEPEȘ	0.039	25.8
	STEFAN VODA	0.038	26.1
	ROSETI	0.037	26.7
3	STEFAN CEL MARE	0.028	35.5
	BORCEA	0.025	39.7
	CHIRNOGI	0.085	11.8
	OLTENITA	0.081	12.4
	SOLDANU	0.053	18.7
	FRUMUSANI	0.032	30.9

Source: Own calculation.

The results show that inside each cluster the producers are at optimum distances from each other, under 50 km. Also, we may notice that the localities Lehliu, Călărași and Chirnogi can be selected as final distribution points inside each supply chain (Figure 3).

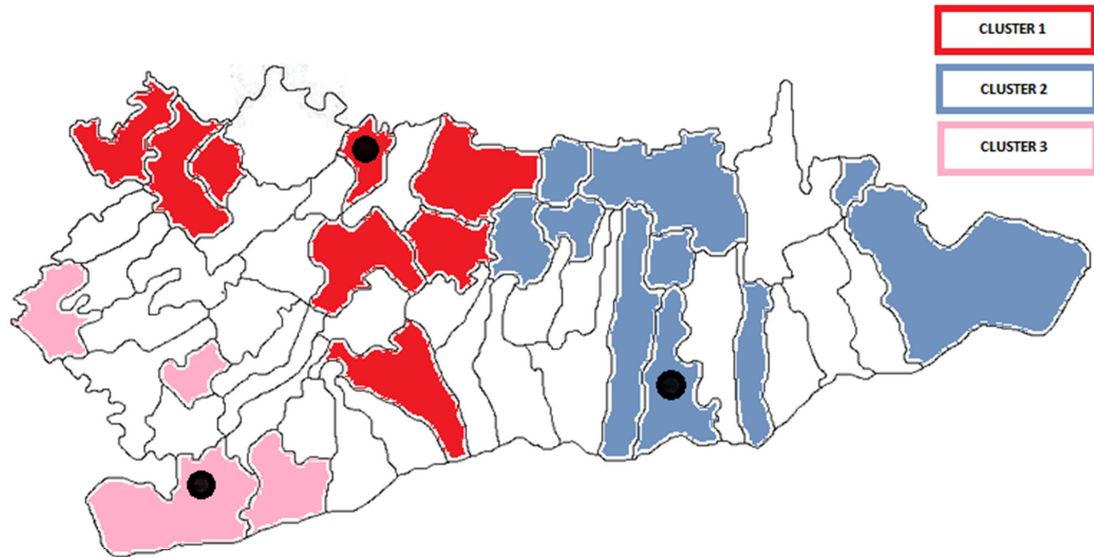


Fig. 3. Clusters distribution

### 3.3. Organic farming patterns

In Cluster 1 there are 10 farms with 237.73 ha and organic agriculture. 50% of these are subsistence farms (under 5 ha), 20% are semi-subsistence farms (5-20 h) and only 30% have a real commercial potential (Table 6). Also, only 40% of the surface is certified. In this cluster, the varieties of farming types makes it very difficult to establish local supply chains.

Table 6. Cluster 1 profile

	Frequency	Percent
<b>Farm type</b>		
BD	2	20.0
CD	1	10.0
SD	5	50.0
SSD	2	20.0
Total	10	100.0
<b>Farming system</b>		
COP	1	10.0
Industrial crops	2	20.0
Forage crops	2	20.0
Horticulture	2	20.0
Orchards-fruits	2	20.0
Mixed crops	1	10.0
Total	10	100.0
<b>Certified area share</b>		
90-100%	4	40.0
Only under conversion	6	60.0
Total	10	100.0

Source: Own calculation

In Cluster 2 there are 26 farms with 6312.6 ha and organic agriculture. 65.4% of these are big farms (over 50 ha) and only 11.5% are subsistence farms (Table 7). 46.2% of these have between 90-100% certified areas and only 26.9% have only surfaces under conversion. Here there is a real potential for the establishment of local supply chains through producers groups especially in COP sector. There are 12 farms with over 4 thou hectares cultivated with cereals, oilseeds and protein plants which can cooperate and promote their area. There is a similar situation in the industrial crops or forage crops sectors.

Table 7. Cluster 2 profile

	Frequency	Percent
Farm type		
BD	17	65.4
CD	3	11.5
SD	3	11.5
SSD	3	11.5
Total	26	100.0
Farming system		
COP	12	46.2
Industrial crops	8	30.8
Forage crops	4	15.4
Horticulture	1	3.8
Mixed crops	1	3.8
Total	26	100.0
Certified area share		
40-50%	1	3.8
50-60%	2	7.7
70-80%	1	3.8
80-90%	3	11.5
90-100%	12	46.2
Only under conversion	7	26.9
Total	26	100.0

Source: Own calculation

In Cluster 3 there are only 4 farms, with a total agricultural area of 366.18 ha, half of which is covered by semi-subsistence farms (Table 8). The particularity of these farms is that they are very specialized, which makes it also very difficult to cooperate inside the same local supply chain.

Table 8. Cluster 3 profile

	Frequency	Percent
Farm type		
BD	1	25.0
CD	1	25.0
SSD	2	50.0
Total	4	100.0
Farming system		
COP	2	50.0
Horticulture	1	25.0
Wine	1	25.0
Total	4	100.0
Certified area share		
60-70%	1	25.0
90-100%	2	50.0
Only under conversion	1	25.0
Total	4	100.0

Source: Own calculation

#### 4. Conclusions

In conclusion, the organic agriculture sector is very scattered in Călărași county, which makes it very difficult to develop producers' groups. However, we consider that the cooperation between at least 20 farmers located in Cluster 2 (specialized in COP, forage and industrial crops) has to be promoted. They can form a viable producers' group and develop a pooling, storage or selling point (with lower transport costs) in Călărași locality through structural funds. In this way, they can integrate in a viable chain, have better control over the costs in the entire chain and increase their profit margins.

#### References

- Alonso, W., 1964. Location and land use. Harvard University Press, Cambridge, USA
- Chomitz, K.M., Gray, D.A., 1996. Roads, land use and deforestation: A spatial model applied to Belize. *World Bank Economic Review*, 103:487–512
- Constantin, F., 2012. Economic performance of organic farming in Romania and the EU. *Economia Seria Management/Economy – Management Series*, 13 (1): 108-119
- Moise, G., 2014. Promotion of ecologic product certification as instrument to speed up the ecologic agriculture. *Scientific Papers. Series "Management, Economic Engineering in Agriculture and rural development"*, Vol. 14(1) 241-244
- Nelson, G.C., 2002. Introduction to the special issue on spatial analysis for agricultural economists. *Agricultural Economics* 27:197–200
- Popa, D., Dona, I., 2012. Estimating the economic potential of rural tourism in the geographical area of Oltenia. *Analele Universității din Oradea, Fascicula: Ecotoxicologie, Zootehnie și Tehnologii de Industrie Alimentară*, 11(B): 173-181
- Popescu, A., Pop C., 2013. Considerations regarding the development of organic agriculture in the world, the EU-27 and Romania. *Scientific Papers. Series "Management, Economic Engineering in Agriculture and rural development"*, Vol. 13(2):323-330
- Scholl, T., Brenner, T., 2011. Testing for Clustering of Industries Evidence from micro geographic data (No. 2011-02). Philipps University Marburg, Department of Geography
- Turner II, B.L., Kasperson, R.E., Meyer, W.B., Dow, K.M., Golding, D., Kasperson, J.X., Mitchel, R.C., Ratick, S.J., 1990. Two types of global environmental change: Definitional and spatial-scale issues in their human dimensions. *Global Environmental Change* 1:14–22
- Verburg, P.H., De Groot, W.T., Veldkamp A., 2003. Methodology for multi-scale land-use change modelling: Concepts and challenges. In: Dolman A.J., Verhagen A. and Rovers 78 C.A. (eds), *Global environmental change and land use*. Kluwer Academic Publishers, Dordrecht, the Netherlands